The Chromaphil Tissues and the Adrenal Medulla.

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(From the Physiological Laboratory, University of Manitoba, Winnipeg, Canada.)

[Plate 13.]

I. *Introductory and Historical.*

The recognition of the extra-adrenal chromaphil* cells in mammals and the characteristic reaction with chromium salts, by which they are now universally designated and homologised with the medulla of the adrenals, is due to Stilling.† This author found in the abdominal sympathetic small bodies composed of cells having the same chromaphil reaction as those forming the medulla of the adrenal. He states that some are nearly a centimetre in length, while others are only just visible to the naked eye. They are round, oval, or elongated in form, and their thickness is never more than a few millimetres. They have a *tunica propria*, small vessels and capillaries. Between the capillaries are cells which resemble in all respects those of the adrenal medulla. The resemblance between the chromaphil corpuscles of the sympathetic and the medulla of the adrenal is rendered all the greater by the occurrence in the latter of occasional nerve cells. Stilling found these corpuscles in the rabbit, the cat, and the dog, and especially in young animals. He gives details of a method for displaying them.

Stilling also discovered that the carotid body contains cells of the same character as those forming the adrenal medulla and the chromaphil corpuscles of the sympathetic.‡ Later, Kohn§ and Kose‖ confirmed and extended these

* The spelling "chromaphil" instead of chromophil was suggested to me by Prof. Schäfer.

† 'Revue de Médecine,' November, 1890, p. 808 ff.

‡ 'Recueil inaugural de l'Université de Lausanne,' 1892.

§ 'Prager med. Woch.,' 1898, Bd. 23, s. 194—195; 'Arch. f. mikr. Anat.,' 1898, Bd. 53, s. 281—312; 'Anat. Anz.,' 1899, Bd. 15; 'Ergebnisse d. Anat. u. Entwick.,' 1899, Bd. 9; 'Arch. mikr. Anat.,' 1900, Bd. 56; 'Prag. med. Woch.,' 1902, Jg. 27; 'Arch. f. mikr. Anat.,' 1903, Bd. 62; 'Allg. Wien. med. Zeitschr.,' 1903, Jg. 48, nr. 46 u. 47; 'Ergebnisse Anat. u. Entwickl.,' 1902, Bd. 12; 'Prag. med. Woch.,' 1903, nr. 42.

‖ 'Sitz. Ber. d. naturw.-med. Ver. f. Böhmen, Lotos,' 1898, No. 6; 'Anat. Anz.,' 1902, Bd. 22; *ibid.*, 1904, Bd. 25.

observations, laying stress on the point that these chromaphil cells are common and typical elements of the mammalian sympathetic system. Kohn's view is that what is ordinarily called the cortex of the adrenal is in reality the only part which ought to be called adrenal at all, while the medulla is simply the "paraganglion suprarenale," a group of what he calls "chromaffine Zellen," which has become included in the adrenal.

Zuckerkandl* in 1901 found in the retroperitoneal space at the origin of the inferior mesenteric artery a pair of large chromaphil bodies which he calls "Nebenkörper des Sympathicus." These he found constantly in the embryo and in the new-born human subject. Biedl and Wiesel† have demonstrated that extracts prepared from them have precisely the same powerful effect upon the blood pressure as have extracts of the medulla of the adrenal.

The extra-capsular chromaphil material is still very imperfectly known to many writers on the physiology and pathology of the adrenals. Thus Rolleston‡ in this relation refers to Zuckerkandl's bodies, the carotid body, the coccygeal body, and some cells in the pituitary. Now the coccygeal body does not contain chromaphil cells,§ nor does the pituitary, so far as I am aware. Zuckerkandl's description applies only to the human subject, and indicates, as we have seen, a *pair* of chromaphil bodies in the retroperitoneal region of the abdomen. But in the dog and other animals there is to be found a very striking mass (or more correctly a "strip") of chromaphil tissue (the "paraganglion aorticum abdominale" of Kohn). This is *unpaired*, and may be called the "abdominal chromaphil body." The existence of this important body is probably unknown to many physiologists and anatomists. Kohn‖ has given an excellent account of this body and the other chromaphil tissues in the human subject, and also in the cat and the rabbit, but his paper does not deal with these structures in the dog. In regard to the general anatomy of the chromaphil bodies in the dog the present communication cannot lay claim to any originality, for Kohn has been kind enough not only to explain to me how to find the bodies, but also to send me illustrative preparations.

The present paper will, I hope, be useful to experimenters and others, inasmuch as it is the only account in the English language of the chromaphil structures, and as it records the results of the examination of a large number

* 'Verhandl. d. Anatom. Ges.,' Bonn, 1901, 15 Vers.; 'Anat. Anz.,' Ergänzungsh. z. 1901, Bd. 19, pp. 95—107.

† 'Arch. f. d. ges. Physiol.,' 1902, Bd. 91.

‡ 'Lancet,' 1907, vol. 2, p. 875.

§ Stoerk, 'Arch. f. mikr. Anat.,' 1903, Bd. 69.

‖ 'Arch. f. mikr. Anat.,' 1903, Bd. 62.

of animals and contains a fuller description of the microscopic structure of the chromaphil bodies than has hitherto appeared.

II. *Methods Employed.*

For the study of the naked-eye anatomy of the mammalian chromaphil tissues the following method (of Kohn and Stilling) has been adopted:—The liver and alimentary tract are removed from the abdomen and a piece of absorbent cotton soaked in a solution of potassium bichromate (3·5 per cent.) is placed over the retroperitoneal tissues and left *in situ* for 6 to 12 hours. At the end of this (or in some cases a longer or a shorter time) the adrenals, aorta, vena cava, and subjacent and superjacent tissues are cut out as far back as the bifurcation of the aorta and washed in running water for several hours. The chromaphil bodies are then plainly seen, and still more plainly if the whole preparation be placed in glycerine. They appear as dark brown streaks, patches, or dots of varying size and shape (see text-figs. 1 to 11).

Another method which gives good results is to first cut out the abdominal vessels and the adrenals with the accompanying tissues and lay the preparation in a solution of potassium bichromate (3·5 per cent.). In rabbits and cats it is recommended that the animals chosen for examination be not too fat.

It is sometimes desirable to make a little further dissection after the action of the bichromate. To see the smaller bodies, a simple lens or a dissecting microscope may be employed. It is best that fresh material should be employed; but fairly good results may sometimes be obtained, even if the animal has been dead for some hours before dissection.

For the microscopical examination of the chromaphil cells and bodies in the first instance, Kohn's fluid (potassium bichromate, 3·5 per cent., 90 c.c.; formol, 40 per cent., 10 c.c.) has been employed, or the bodies revealed macroscopically by the application of bichromate have been washed, passed through alcohol, and treated by any of the usual methods for microscopical preparation.

But bichromate solutions, even with the addition of a certain proportion of formol, do not give the best results for detailed histological examination, howsoever convenient they may be for identification of chromaphil cells. For this reason, after the bodies have once been carefully located by means of the bichromate, from subsèquent specimens they have been fixed in corrosive sublimate, Flemming's fluid, and other approved agents. The sections were stained in various ways. For the small groups of chromaphil cells in the sympathetic ganglia, it has been necessary to employ bichromate solution

throughout, because otherwise it is almost impossible to recognise them in sections.

The following species have been examined:—Dog, cat, rabbit, guinea-pig, white rat, mouse, monkey (macacus), pig, gopher (*Spermophilus Franklini*), sciurus (species not identified).

III. *The Chromaphil Cells in the Sympathetic Ganglia.*

According to Kohn and Kose, groups of chromaphil cells are regularly found in the ganglia of the sympathetic chain, and in numerous ganglia and nerves of the peripheral sympathetic plexuses.

V. Ebner,* in reference to these cells, speaks doubtfully, "nach eigenen, allerdings nur flüchtigen Beobachtungen kann ich vorläufig an das regelmässige Vorkommen von 'chromophilen' oder 'chromaffinen' Zellen in den Ganglien des Sympathicus bei Sängern nicht glauben und halte vor allein nicht für erwiesen, dass die in Chromsalzen sich gelb färbenden Zellen des Sympathicus mit den Markzellen der Nebenniere identisch sind, da diese Farbenreaktion für sich allein nicht beweisend ist." He points out with perfect justice that in order to prove that these groups of cells are identical with those of the adrenal medulla, something further than the chrome reaction is necessary, and remarks that too much stress should not be laid upon the common origin of the adrenal medulla and these cells from the sympathetic.

I must confess to having felt very similar doubts at an early stage of the investigation. But although these chromaphil cells in the sympathetic ganglia are not, perhaps, so common as one might be led to conclude from a perusal of Kohn's papers, yet if a large number of sections be cut, one can scarcely fail to find them, at any rate in the larger ganglia.

Plate 13, fig. 3, shows a section through a group of chromaphil cells in the inferior cervical ganglion of a dog. The tissue was fixed in Kohn's fluid, and the sections were stained with hæmalum. The group of cells measures 0·12 mm. by 0·1 mm., and stands out prominently from the nervous tissue by reason of the brown stain of the cytoplasm, and in many cases of the nucleus also.

The mass of cells is not divided up into distinct columns and smaller masses as is the case with the abdominal chromaphil body (*cf.* fig. 4), and the adrenal medulla (*cf.* figs. 2 and 5), but there are traces of such division indicated by wavy lines which have not taken on the chrome reaction (see fig. 3).

The cell-outlines are for the most part distinctly seen, and are indicated in many cases by a light (unstained) ring, which is again surrounded by a dark,

* Kölliker's 'Handb. d. Gewebelehre,' 1902, 6te Aufl.

slightly irregular border (Plate 13, fig. 3, *chrom. c*). The cells are about 15 μ in diameter, and the protoplasm is very finely granular. The brown tint varies in intensity in different cells and in different parts of the same cell.

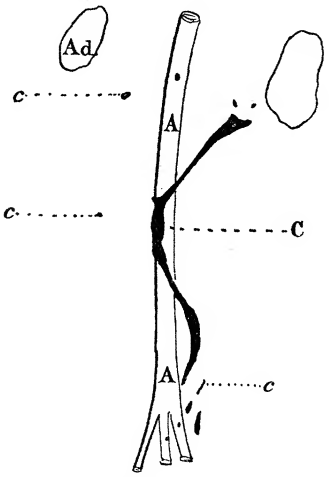
The nuclei are large in proportion to the dimensions of the cells, and are on an average 7 μ in diameter (see fig. 3, *n*). The majority are stained brown by the bichromate, and the outlines are distinct and dark brown, while the interior is usually clearer. There is sometimes a distinct nucleolus, and the outer portion of the nucleus is studded with small dark brown granules (fig. 3, *n*).

Nuclei belonging to nerve-fibres are also to be seen within the area of the group of chromaphil cells (fig. 3).

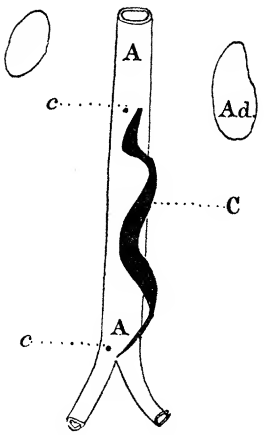
IV. *The Abdominal Chromaphil Body and other Accumulations of Chromaphil Cells.*

a. *Macroscopic.*

In the *dog*, the extra-adrenal chromaphil tissues are specially abundant, and the abdominal chromaphil body is easily and beautifully shown by the method above described. A few minutes after the mop of absorbent cotton soaked in bichromate has been placed over the aortic region, a long



TEXT-FIG. 1.—Abdominal Chromaphil Body of an Adult Dog.
A = Aorta; Ad. = Adrenal; C = Abdominal chromaphil body; *c* = Smaller chromaphil bodies.

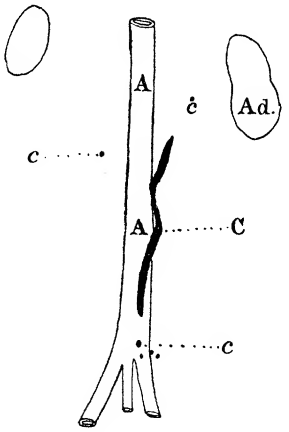


TEXT-FIG. 2.—Chromaphil Body of Adult Dog. Same lettering as text-fig. 1.

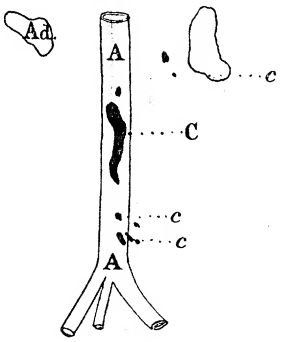
brown streak of rapidly deepening tint may be seen lying over the aorta, or slightly to one or the other side. In from half an hour to an hour its deep

brown stain is fully developed, and the relations of the body can be determined.

It varies in length in the dogs I have dissected from 1 to 4·5 cm., and its width varies from a very fine line to about 5 mm.



TEXT-FIG. 3.—Chromaphil Bodies of an Adult Dog. Lettering as in previous figures.



TEXT-FIG. 4.—Chromaphil Bodies of a Young Dog. Lettering as in previous figures.

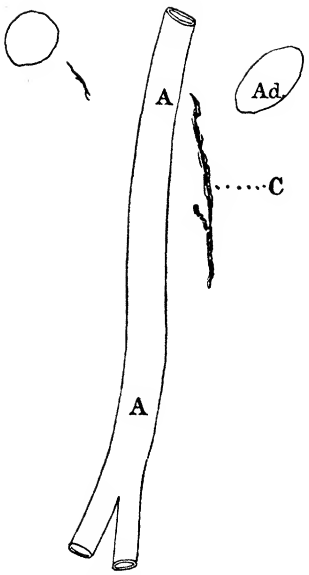
Some illustrations of the variations in size and shape which may be met with are furnished by the text-figs. 1 to 4. The body is flattened dorso-ventrally, so that its thickness is not more than 0·2 to 0·3 mm. It varies considerably in width from place to place, is frequently branched, and shows broken-off portions. The principal body is unpaired.

Numerous irregularly placed small nodules of chromaphil tissue are seen in different regions in more or less close connection with the principal chromaphil body (see text-figures 1 to 4, *c*).

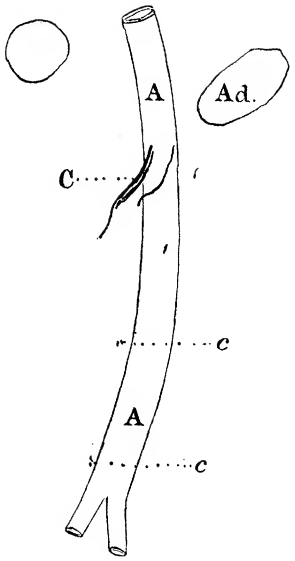
In the *cat*, the chromaphil bodies are not so large and dense as in the dog. They have been fully described by Kohn*, and, as will be seen from his drawings, as well as from those here given (text-figures 5 to 9), consist of long threads of tissue instead of ribbons of varying width as in the dog. These threads are stretched out along the sympathetic nerves, and the relation of the chromaphil tissue to the sympathetic is closer, or at any rate more obvious, than in either the dog or the rabbit. Small scattered chromaphil corpuscles are found in different regions, as in the dog (text-figures 5, 6, 7, 8, *c*).

In the *rabbit*, the threads of chromaphil tissue are thicker than in the cat.

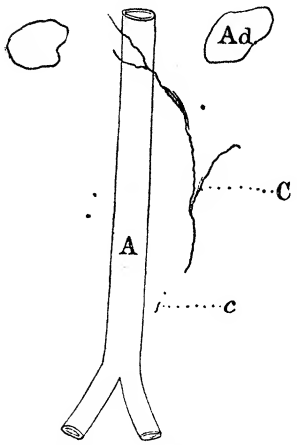
* 'Arch. f. mikr. Anat.,' 1903, Bd. 62, s. 317 ff.



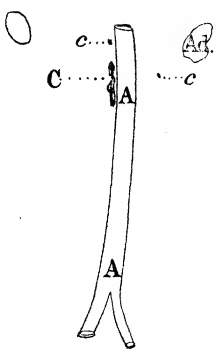
TEXT-FIG. 5.—Abdominal Chromaphil Bodies of an Adult Cat. Lettering as in previous figures.



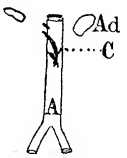
TEXT-FIG. 6.—Abdominal Chromaphil Bodies of an Adult Cat. Lettering as in previous figures.



TEXT-FIG. 7.—Chromaphil Bodies of Adult Cat.

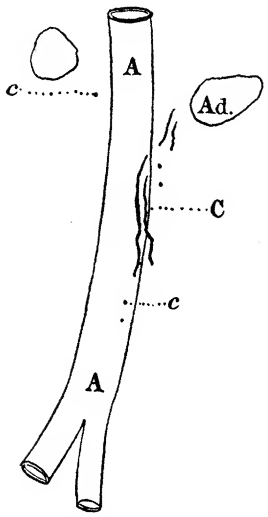


TEXT-FIG. 8.—Chromaphil Bodies of Young Cat.

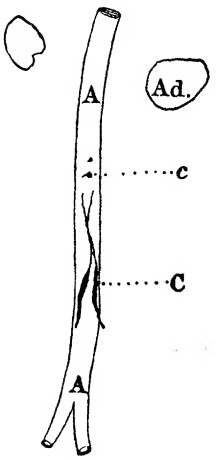


TEXT-FIG. 9.—Chromaphil Bodies of Newborn Kitten.

There is a tendency for the principal chromaphil body to be paired (text-fig. 10). Where this is not the case it is frequently bifurcated, anteriorly and posteriorly (text-fig. 11). The threads frequently run close to the adrenal, and are occasionally continuous with the medullary substance. This



TEXT-FIG. 10.—Abdominal Chromaphil Bodies of a Rabbit. Lettering as in previous figures. The principal body is paired, as also is a continuation towards the adrenal on one side.



TEXT-FIG. 11.—Abdominal Chromaphil Bodies of a Rabbit. Lettering as in previous figures. The principal body is bifurcated anteriorly and posteriorly.

is shown in one of Kohn's drawings, and corresponds with what I found some years ago in the young rabbit. I described the appearance as follows:—"In young animals one sometimes finds that the medulla has not yet become completely surrounded by cortex, but comes to the surface at some point. In the case of the suprarenal capsule of a young rabbit, I noted a very interesting appearance. Near that part of the circumference where the medulla reached the surface was a sympathetic ganglion outside the capsule of the organ. Near to it, also outside the capsule, was a mass of cells resembling those of the suprarenal medulla, only not so uniformly stained by the bichromate."* This was clearly a group of chromaphil cells, and if serial sections had been cut, doubtless a direct continuity between it and the medulla would have been seen.

In the other animals examined, viz., monkey, pig, guinea-pig, rat, gopher and squirrel, no chromaphil bodies have been recognised with certainty. This is especially interesting in the case of the rat. Schäfer† recently exhibited a white rat which was operated upon by Harley some time between 1856 and 1858. This rat had the spleen and adrenals extirpated when it was only a month old and quite small. It increased in size after

* 'Internat. Monatsschr. f. Anat. u. Physiol.,' 1898, Bd. 15, Heft 10 u. 11.

† Oliver-Sharpey Lectures, 'Brit. Med. Journ.,' May 30, 1908.

the operation quite as fast as its fellows which had not been touched. The animal was killed when five months old, and no discoloration of the skin or hair could be detected. Commenting upon this Prof. Schäfer says "the rat happens to be the one common animal which is able to withstand complete removal of both suprarenal capsules. The reason for this was not at the time apparent, although it is now known, for the rat is exceptional in possessing in various parts of the back of the abdomen and pelvis numerous small glandular structures which are composed of cells having the characteristic features and functions of the cells of the suprarenal medulla."

I have carefully examined several white rats, but have failed to find any traces of extra-adrenal chromaphil tissue. There is probably, however, some difference in this respect between the different varieties of rats, for Dr. Kohn informs me that he has found an abdominal chromaphil (paraganglion aorticum abdominale) in a rat which he dissected, and he has sent me an illustrative sketch. But he is of opinion that the rat does not possess a greater abundance of chromaphil tissue than other animals.

From the large size of the chromaphil body in the dog one would expect to find this animal more resistant to adrenal extirpation than other animals, if the chromaphil tissue be looked upon as essential to life. But the experimental evidence bearing upon the relative importance to life of cortex and medulla is very contradictory.*

b. *Microscopic.*

My investigations upon the minute structure of the abdominal chromaphil bodies have been confined to the dog. In this animal the body is large enough to be found without treatment with bichromate, and so can be dissected out and fixed in any fluid one chooses.

In preparations made with bichromate solutions (*e.g.*, Kohn's fluid, *vide supra*) the chromaphil cells are stained of a tint which varies from a light yellow to a deep brown, according to the duration of the treatment with the solution, and apparently also according to physiological conditions in the cells.

Plate 13, fig. 4, shows a transverse section through the abdominal chromaphil body (dog) fixed in Kohn's fluid. The section is seen to be divided up into a number of irregular areas which represent the cross-sections of columns of cells which run longitudinally. The width of these columns varies considerably (see Plate 13, figs. 1 and 4). They are divided

* For a discussion of this subject see Vincent, 'Ergebnisse der Physiol.,' 1910.

from each other by strands of connective tissue with a large amount of elastic tissue and blood-vessels and nerves. In the spaces between the columns is also accumulated a quantity of homogeneously stained material which appears to resemble the colloid of the thyroid. This seems to be in some instances contained in lymph spaces.

The cells are irregular in shape (Plate 13, fig. 4), but tend, like those of the chromaphil groups in the sympathetic ganglia, to be circular in outline (*cf.* Plate 13, fig. 3 and fig. 4, *chrom. c*). They have an average diameter of about 12 μ. Thus they are slightly smaller than those in the ganglia.

The protoplasm is very finely granular or almost homogeneous, and the intensity of the brown coloration varies considerably in different cells (Plate 13, fig. 4), so that their outlines are often indicated by this means. Some cells scarcely show the brown coloration, and the region of the protoplasm is indicated as a light ring round the nucleus.

A very striking feature of the preparation is the appearance in all parts of the section of a number of clear spaces with very definite outlines (Plate 13, fig. 4, *v*). These appear in many instances to contain a substance resembling the colloid above referred to, and occur both between the cells and within their substance.

The nuclei are 5 or 6 μ in diameter, and resemble those of the groups of chromaphil cells within the ganglia (Plate 13, figs. 3, *n*, and 4). In many of my slides a very interesting arrangement is seen. The nuclei of the cells are frequently disposed in a regular row around the circumference of the cell-columns.

When the material is fixed in corrosive sublimate and subsequently stained with hæmalum or carmalum many of the features above described are seen with greater distinctness. Thus the cell outlines are more regularly and more distinctly seen, and the shape and relations of the cell-columns are more easily studied. Specimens of the abdominal chromaphil body of the dog have been removed immediately after the death of the animal, and after being pinned out on cork to prevent shrinking or curling have been fixed in acid mercuric chloride solution. Sections have been subsequently cut in three directions, viz., transversely, longitudinally and horizontally, and longitudinally and vertically (Plate 13, fig. 1).

The organ is surrounded by a connective tissue capsule containing vessels and nerves (fig. 1, *c*). It is clear that the cell-columns run longitudinally, and are somewhat wider in the horizontal than in the vertical direction. There is considerably more variation in the width of the columns in a horizontal direction than in the vertical. In the former direction the columns have an average width of 52 μ, in the latter about 22 μ. The

average size of cells and nuclei is given above in connection with the bichromate preparations.

The vacuoles so prominent in bichromate specimens are not to be seen in the preparations fixed in corrosive sublimate or Flemming's fluid (*cf.* fig. 1 with fig. 4).

As already pointed out by Kohn,* the abdominal chromaphil bodies occur in two principal forms, the globular and the elongated. These last are often in the form of threads. The first form is typically found in the human subject; the last in other mammals, such as cats and rabbits. In these animals the threads or columns run separately for the most part, while, as we have seen, in the dog they are united into a compact ribbon-like organ.

In the fœtal kitten, the chromaphil body is short, almost oval in shape, and the columns of chromaphil cells form an irregular network. Kohn gives an excellent drawing of the microscopical structure of this body, so that a description in this place is unnecessary.

V. *The Adrenal Medulla.*

There is no need to give a description of the general structure of the medulla of the adrenal. The structure has been described by numerous observers, and is generally known. It is, however, desirable to institute some comparisons between the histological appearances of the adrenal chromaphil tissue and this substance as it occurs in other places, as, for example, in the sympathetic ganglia and in the abdominal chromaphil bodies.

The present observations are confined to the adrenal of the dog, just as the descriptions of the abdominal chromaphil body are limited to this animal.

A comparison of Plate 13, fig. 1, with fig. 2 or of figs. 3 and 4 with fig. 5, will show that the general resemblance between extra-adrenal chromaphil tissue and adrenal medulla is very great. Both consist of columns of cells staining yellow or brown with bichromate of potash. The cell-columns are, however, for the most part much thicker in the adrenal than in the abdominal chromaphil bodies. The blood-spaces are wider, and the whole aspect gives the impression that the adrenal medulla is more highly organised (see Plate 13, fig. 2, *bld. v, col. c*).

Many of the cells of the adrenal medulla are spherical, as in the abdominal chromaphil body, and their dimensions are the same, viz., about 12 μ in diameter. The nuclei, also, are of the same order of magnitude in both structures, viz., 5 or 6 μ. But in many regions, especially where the cell-columns are separated by large venous sinuses, the cells are arranged in a definitely epithelial fashion round the blood-vessels (Plate 13, fig. 2, and

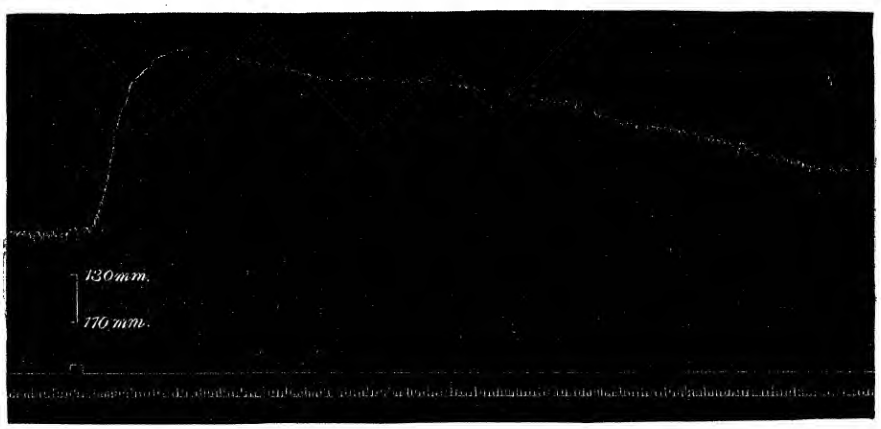
* 'Arch. f. mikr. Anat.,' 1903, Bd. 62, s. 327.

fig. 5, *col. c*). In this case the cells are columnar in shape, and may reach a length of 26 μ, and the nuclei are placed at the end of the cell remote from the blood-vessel.

The protoplasm of the adrenal medulla is more distinctly granular than that of the abdominal chromaphil body, and is, moreover, more delicate in consistence, and therefore shows more shrinkage in fixation and tearing during the process of cutting sections. When the adrenal is fixed in bichromate solutions, the section shows vacuoles similar to those described above in the chromaphil body. These are absent in sublimate and Flemming preparations. Thus it seems justifiable to regard the medulla of the adrenal body as composed of chromaphil cells of the same general character as those forming the chromaphil bodies. But the former have undergone specialisation, and the structure of the substance has become elaborated into an organ with more definitely glandular form.

VI. *The Question as to the Secretory Activity of the Chromaphil Tissues.*

It is clear from all that has gone before that the extra-adrenal chromaphil tissues contain a substance which gives the same macro- and micro-chemical reactions as adrenin. It has been shown by Biedl and Wiesel* that the "parasomata" (Nebenkörper) discovered by Zuckerkandl in the human subject contain adrenin or some substance which has an identical effect upon the blood-pressure. I have recently been able to prove that the abdominal chromaphil bodies of the dog contain the same or a similar substance. Text-fig. 12 shows the effect of injecting into the saphenous vein of a dog an



Text-fig. 12.—Dog, 8 kilogrammes. November 10, 1909. $CHCl_3$, morphia, atropine. Carotid blood-pressure. Time in seconds. At the point signalled an extract from the chromaphil bodies of three dogs was injected into the saphenous vein.

* 'Arch. f. d. ges. Physiol.,' 1902, Bd. 91.

extract made from the abdominal chromaphil bodies of three dogs. It will be seen that the effect is identical with that of adrenin. In the same experiment, a further injection of an extract made from the abdominal chromaphil bodies of two dogs produced a comparable rise of blood-pressure.

Mulon* has raised the blood-pressure of an animal by injection into the circulation of an extract made from the carotid body of the horse.

It seems clear, therefore, that all chromaphil tissues, whether contained in the adrenal or not, yield adrenin, or a substance having similar chemical and pharmacodynamical properties. According to the views of the majority of recent observers, the presence of this substance may be considered, in conjunction with other observations, as evidence of an internal secretion on the part of all these tissues. Kohn,† from morphological considerations, is opposed to this view. He is certainly correct in insisting that because adrenin has certain pharmacodynamic properties we have no right to assume, without further definite evidence, that it is one of the functions of the tissue to pour out this substance into the blood-stream in order to produce beneficial effects upon certain tissues of the body. He considers that the cells forming the medulla of the adrenal and chromaphil tissue elsewhere are not "epithelial," and therefore cannot secrete. The present writer has replied to this argument on a previous occasion,‡ and a fuller discussion of the subject has recently appeared.§ It must be admitted that the experimental evidence on the point is contradictory, but there seems no reason why one cannot admit the hypothesis that all the chromaphil cells have an internal secretion, though this process is more completely elaborated in the large chromaphil bodies, and more especially in the adrenal medulla.

The presence of a large strip of chromaphil tissue in the abdomen of the dog and other animals, outside of the adrenals, is a very important consideration in all extirpation experiments, and the wide distribution of this tissue in the body renders its complete removal impossible.

EXPLANATION OF PLATE 13.

(Lettering common to all the figures.)

bld. c., blood corpuscles ; *bld. v.*, blood vessels ; *c.*, capsule ; *chrom. c.*, chromaphil cells ; *col. c.*, columnar cells of adrenal medulla ; *conn. t.*, connective tissue ; *end.*, endothelium of blood vessels ; *n.*, nuclei ; *n.c.*, nerve cells ; *n.f.*, nerve fibres ; *v.*, vacuoles.

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* 'Arch. gén. de Méd.,' 1903, Année 81, T. 2, No. 52.

† *Loc. cit.*

‡ 'Anat. Anz.,' 1900, Bd. 18.

§ Vincent, 'Ergebnisse der Physiol.,' 1910.

Fig. 1

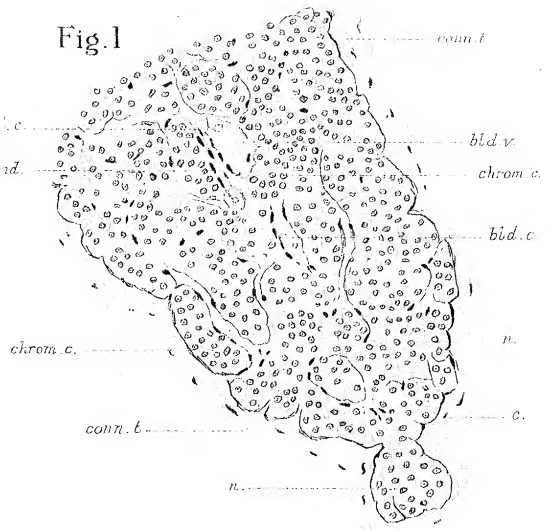


Fig. 2

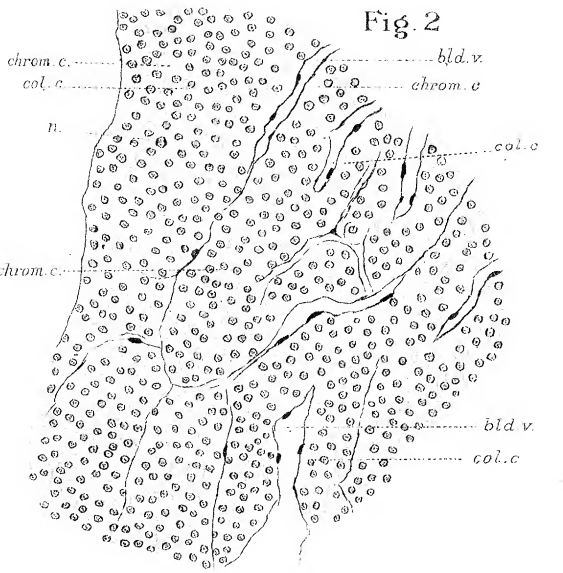


Fig. 3

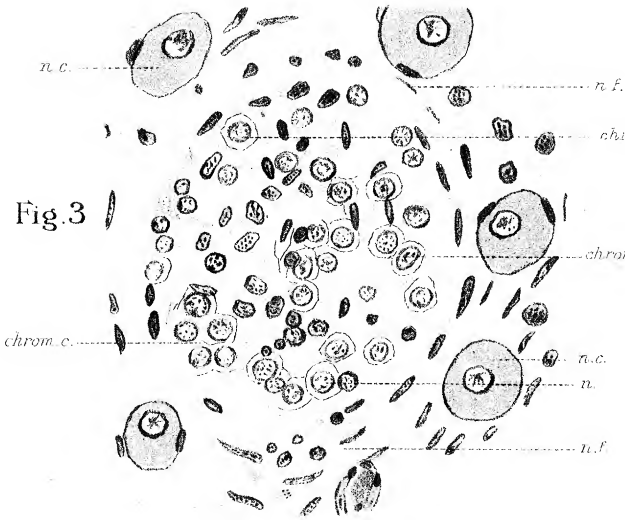


Fig. 4

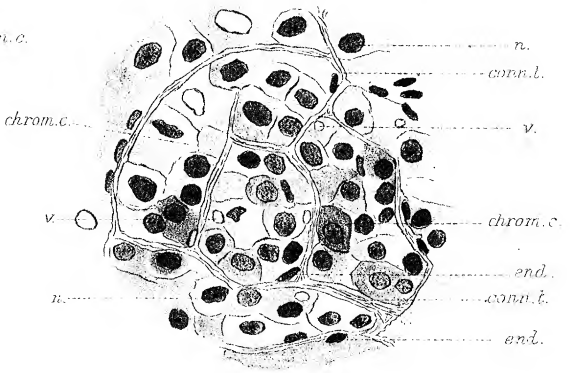
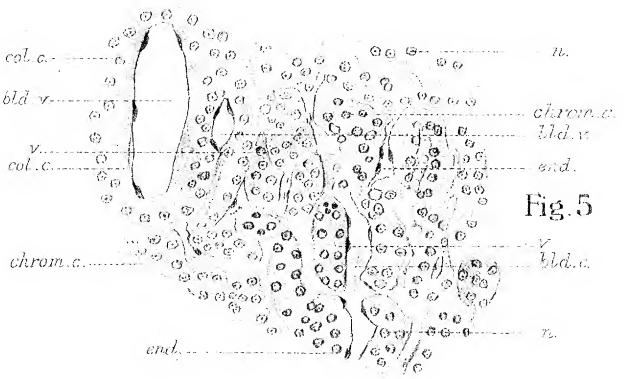


Fig. 5



Purbrook & Eyres, Lith.

FIG. 1.—Transverse section through the abdominal chromaphil body of the dog. Fixed in corrosive sublimate and stained with hæmatoxylin. Section 10 μ in thickness. Leitz, obj. 6. Drawing ocular.

FIG. 2.—Section through the medulla of the adrenal of a dog, prepared as in case of previous figure. Same magnification.

FIG. 3.—Section through a group of chromaphil cells in the inferior cervical ganglion of the dog. Fixed in Kohn's fluid (bichromate-formol, see text). Leitz, $\frac{1}{12}$" oil immersion. Drawing ocular.

FIG. 4.—Transverse section through the abdominal chromaphil body of the dog. Fixed in Kohn's fluid (*v. supra*), stained with hæmatoxylin. Leitz, $\frac{1}{12}$" oil immersion. Drawing ocular.

FIG. 5.—Section through the medulla of the adrenal of a dog. Kohn's fluid. Hæmatoxylin. Leitz, obj. 6. Drawing ocular.

On the Occurrence of a Mesocœlic Recess in the Human Brain, and its Relation to the Sub-Commissural Organ of Lower Vertebrates; with special reference to the Distribution of Reissner's Fibre in the Vertebrate Series and its possible Function.

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[PLATE 14.]

I. *Introductory.*

Eight years ago one of us (Dendy, 1902) published in the 'Proceedings' of the Royal Society a description of a peculiar structure lying beneath the posterior commissure in the brain of the Ammocœte, in the shape of a pair of longitudinal grooves lined by greatly elongated and apparently ciliated columnar cells, and evidently formed by specialisation of the ependymal epithelium which lines the cavity of the brain. Previous to this time there appear to have been, at the most, only a few scattered references to the occurrence of any such structure in the vertebrate brain. We now know, however, that it occurs throughout the whole vertebrate series, from the lampreys to the primates, it having recently been figured, in the case of *Macacus*, by Sir Victor Horsley (1908).

Fig 1

Fig 2

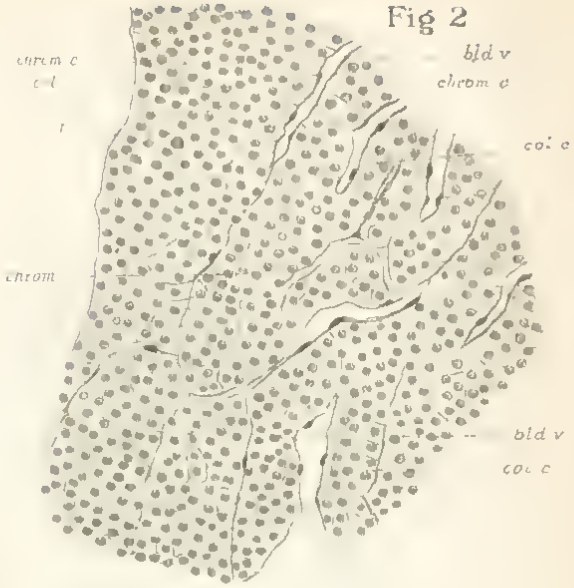


Fig 3

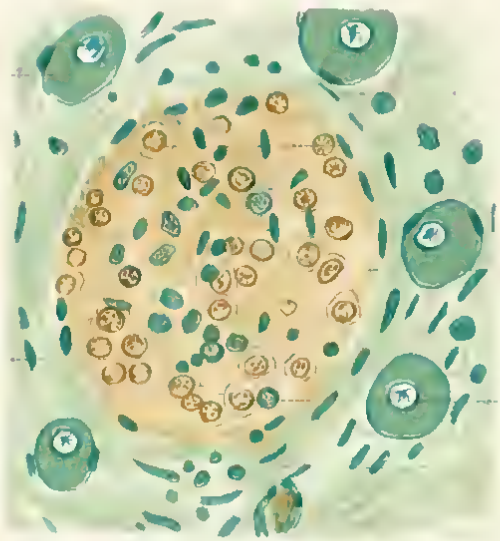
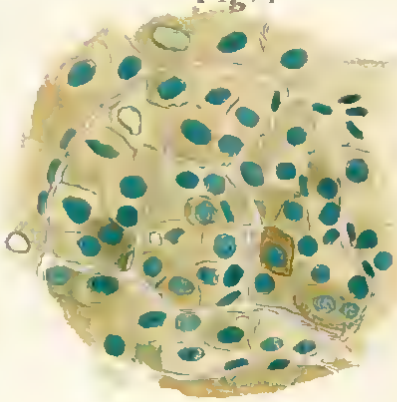


Fig 4



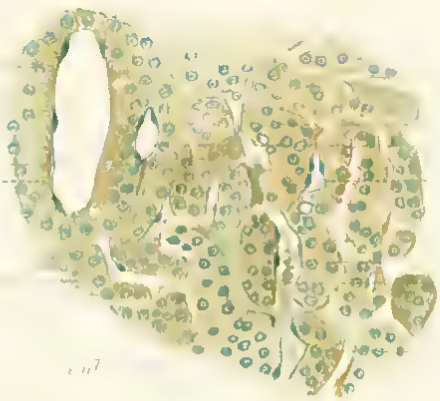


Fig 5